

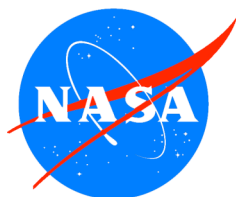
NASA SCIENCE MISSION DIRECTORATE

Earth-Sun System Applied Sciences Program Water Management Program Element FY 2005-2009 Plan



Version 1.1

March 16, 2005



*Expanding and accelerating the realization of economic and societal
benefits from Earth-Sun System science, information, and technology*

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NASA Science Mission Directorate
Earth-Sun System Division
Applied Sciences Program

Applied Sciences for the Water Management Program Element

This document contains the Water Management Program Element Plan for Fiscal Years 2005-2009. This plan derives from direction established in the NASA Strategic Plan, the Earth Science Enterprise Strategy, the Space Science Enterprise Strategy, the Earth Science Applications Plan, and OMB/OSTP guidance on research and development. The plan aligns with and serves the commitments established in the NASA Integrated Budget and Performance Document.

The Program Manager and the Applied Sciences Program leadership have reviewed the plan and agree that the plan appropriately reflects the goals, objectives, and activities for the program element to serve the Applied Sciences Program, the Earth-Sun System Division, NASA, the administration, and society.

(Signature on file)

Jared K. Entin
Program Manager, Water Management
Applied Sciences Program
NASA Earth-Sun System Division

February 11, 2005

Date

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Lawrence Friedl
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NASA Earth-Sun System Division: Applied Sciences Program Water Management

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NASA Science Mission Directorate – Applied Sciences Program

Water Management Program Element Plan: FY 2005 - 2009

I. Purpose and Scope

This plan articulates the goals and direction of the Water Management Program Element for the period from Fiscal Years (FY) 2005 to 2009 by detailing the purpose of the program and our strategy to fulfill the Water Management mission with the resources available. The plan describes the Program's scope, including NASA's role in partnerships, the focus on decision support tools, and the types of science research results we seek to extend. Within the Earth-Sun System Division, this plan functions as a program management tool, describing the program structure, functional mechanisms, performance measures, and general principles that the Water Management activity will follow. The plan includes projects in which science research results can be applied to decision making with related socioeconomic benefits.

The Water Management Program Element is one of twelve elements in the Applied Sciences Program. NASA collaborates with partner organizations to enable and enhance the application of NASA's Earth-Sun System science research results to serve national priority policy and management decision-support tools. The desired outcome is for partner organizations to use project results, such as prototypes and benchmark reports, to enable expanded use of Earth science products and enhance their decision-support capabilities.

The Water Management Program Element extends products derived from Earth science information, models, technology, and other capabilities into partners' decision support tools for water management issues. NASA partners with Federal agencies and other organizations that have water management responsibilities and mandates to support water resource managers. The program may include activities with international organizations, through involvement of US partner organizations. Partnerships with the U.S. Environmental Protection Agency (EPA), Department of Interior Bureau of Reclamation (BoR), and United States Department of Agriculture (USDA) have been established. The program values additional partnerships, including those with international collaborators.

The Water Management Program Element addresses issues of concern and decision-making related to water quality and availability. Some activities relate to the Coastal Management, Agricultural Efficiency, Disaster Management, and Energy Forecasting program Elements. The Water Management Program Element extends NASA research results to decision support tools and serves the following classes of issues related to water availability and quality:

- Estimating water storage – snowpack, soil moisture, and aquifers.
- Modeling and predicting water fluxes – evapotranspiration, precipitation, river runoff.
- Remote sensing of water quality – turbidity, dissolved oxygen.

Measurements from sensors on Earth Science missions for the Water Management Program Element include: (current) Aqua, Terra, GRACE¹, TRMM, EO-1, (future) CloudSAT, GPM,

¹ All Acronyms are listed in Appendix D. Corresponding websites are provided when possible.

NPP, NPOESS, and Hydros. There are numerous land surface, mesoscale, and GCM Earth science models that provide useful, water-related assessments, including: LSMs CLM, Mosaic, NOAH, and VIC supported by the Land Data Assimilation System (LDAS) and Land Information System (LIS); mesoscale models MM5 and RAMS; and GCMs run by GISS, GMAO, GFDL, and NCAR. The project plans associated with the Water Management Program Element designate specific sensors and models, and they state specific activities with the partners to extend Earth-Sun science measurements, environmental data records, and geophysical parameters.

Scope within NASA and Applied Sciences Program

The Water Management Program Element is managed in accordance with, and is guided by, the NASA Strategic Plan and Earth Science Enterprise Strategy. The program element benefits from Earth-Sun system science results and capabilities including Operation System Simulation Experiments (OSSEs), Project Columbia, the Joint Center for Satellite Data Assimilation (JCSDA), the Earth-Sun System Gateway (ESG), and the Transition from Research to Operations (R2O). The program element utilizes initiatives such as the Global Information Grid (GIG) and Federal Enterprise Architecture (FEA) and cooperates with national Earth-Sun laboratories and international programs.

The FY05 President's Budget for the NASA Applied Sciences Program* specifies \$54M annually for FY05-FY09 for the National Applications (\$24M) and Crosscutting Solutions (\$30M) activities. While directly managing a subset of the \$24M National Applications budget, the Water Management Program Element (and each of the national applications) benefits from the performance results of the \$30M budget for Crosscutting Solutions (see Crosscutting Solutions Program Element Plan). The Water Management Program Element leverages and extends research results from the approximately \$2.1B per year supporting Earth-Sun system science research and development of innovative aerospace science and technology.

Additional information about the NASA Applied Sciences Program can be found at <http://science.hq.nasa.gov/earth-sun/applications>.

** The National Applications and Crosscutting Solutions components of the Earth Science Applications Theme in the NASA FY05 Integrated Budget & Performance Document*

This plan covers objectives, projects, and activities for Fiscal Years 2005-2009. In Fiscal Year 2005 (FY05), the Program Element's priority activities focus on extending MODIS and LDAS / LIS products to three management decision support systems (DSSs): BASINS (EPA), AWARDS (BoR), and Riverware (BoR). Other lead activities include identification of NASA resources to augment performance of the SWAT model (USDA), used as a basis for BASINS and USDA DSSs, and Impact-Water, an international policy-oriented DSS implemented by the University of Colorado.

Plans are being formulated to transfer NASA expertise and experience specifically in the fields of data assimilation to NOAA's Office of Hydrologic Development. The end intention of this transfer is the augmentation of the (NWS) operational DSTs. Significant potential exists to support the NWS's Advanced Hydrologic Prediction System (AHPS), the proposed Community Hydrologic Prediction System (CHPS) and the National Digital Forecast Database (NDFD). The DST targeted for improvement is the NWS River Forecast System (NWSRFS), which includes the Ensemble Streamflow Prediction (ESP) Subsystem and the Distributed Hydrologic Modeling System (DHMS). The primary data sets include MODIS land surface products (snow cover, land cover, LAI, etc.), the NASA LIS modeling of water availability, and AMSR-E soil moisture and snow water equivalent products.

In FY06-FY09, the Program Element's priorities focus on evolving products for DSSs as well as expanding the variety of measurements and model products to be tested for use in these and other water management decision support tools. Also, potential products of planned satellites (e.g. Aquarius and Hydros) need to be evaluated for their potential to augment current and future DSSs. This can be done by adapting the Observation System Simulation Experiments (OSSEs) already developed by the specific spacecraft mission science teams. Potential future observational spacecraft products should be evaluated for both direct use within DSSs, and for indirect use through modeling to improve model output that is used by DSSs.

II. Goals and Objectives

The goal of the Water Management Program Element is to:

Enable partners' beneficial use of NASA Earth-Sun System science observations, models, and technology to enhance decision support capabilities serving their water management and policy responsibilities.

Major tenets of the Water Management Program Element's goal include:

- Develop and nurture partnerships with appropriate water management organizations
- Identify and assess partners' water management responsibilities, plans, and decision support tools and evaluate capacity of NASA Earth-Sun system science results to support the partners
- Validate and verify application of NASA Earth-Sun system science results with partners' DSSs
- With partners, document value of Earth-Sun system science results relative to partners' obligations and support adoption into operational use
- Communicate results and partners' achievements to appropriate water communities and stakeholders

Objectives

The Water Management program serves the NASA Strategic Plan Objectives 1.2 and 3.1, and the NASA Integrated Budget and Performance Document (IBPD) Performance Measure 5ESA8 (ifmp.nasa.gov/codeb/budget2005/ or www.nasa.gov/about/budget/index.html).

The Water Management Program Element pursues the following near-term and long-term objectives:

Near-term Objectives (FY05)

- By May 2005, make grant awards to projects that investigate the extension of NASA Earth science research results towards applications, through the NASA Energy- and Water- cycle Study (NEWS) research announcement.
- By July 2005, establish MOU with Bureau of Reclamation
- By August 2005, complete evaluation reports of three priority decision support tools [BASINS, RiverWare/URGWOM, AWARDS]
- By September 2005, complete JPIP with Bureau of Reclamation and/or DOI
- By May 2005, investigate linkages with IWGEO and CCSP

Long-term Objectives (FY06-FY09)

- By December 2005, complete evaluation report for Impact-Water
- By May 2006, verify and validate Earth-Sun System science inputs into at least three separate water decision support tools and policy/management activities;
- By May 2006, complete at least one benchmark report and conduct one results conference on Earth science inputs into a water decision support tool
- By March 2007, verify and validate Earth-Sun System science inputs into Impact-Water and NWSRFS DSS
- By September 2007, establish agreements with an additional federal partner and at least one non-federal partner
- By September 2007, complete an additional two benchmark reports
- By September 2008, publish at least three articles on water applications of Earth science, including at least one in a peer-reviewed journal
- By March 2009, have completed a total of five benchmark reports and conduct at least three results conferences on at least three separate decision support tools and/or water issues

III. Program Management and Partners

Program Management

Program Manager: *Jared Entin, NASA-Headquarters*

Responsibilities include:

- Program development, strategy, plans and budgets
- Program representation, advocacy, and issues to Applied Sciences management and beyond

- Communication of Science Mission Directorate priorities and directives to Water Management team and network
- Implementation of interagency agreements and partnerships
- Monitor Water Management Program measures and performance evaluation

Deputy Program Manager: *David Toll, NASA-GSFC*

Responsibilities include:

- Leadership on project plans, development, performance, and partnership relationships
- Communication of project metrics, performance, status, and issues to Program Manager
- Leadership & communication to Water Management team & network
- Liaison with Science program: LDAS/LIS
- Management of Water Management Program tasks at GSFC
- Coordination between NASA centers on Water Management activities

Partners

The Water Management Program maintains a network of organizations and points-of-contact associated with water management activities.

Earth –Sun System Division and NASA Centers:

Water and Energy Cycle Focus Area.....	Jared Entin, NASA HQ
Climate Change & Variability Focus Area	Don Anderson, NASA HQ
Weather Focus Area.....	Ramesh Kakar, NASA HQ
Atmospheric Dynamics & Precipitation	Ramesh Kakar, NASA HQ
Climate Modeling	Don Anderson, NASA HQ
Computation.....	Tsengdar Lee, NASA HQ
Cryospheric Processes.....	Waleed Abdalati, NASA HQ
Technology	Parminder Ghuman, NASA ESTO
Business & Budget.....	Joan Haas, NASA HQ
Ames Research Center (ARC)	Steve Hipskind
Goddard Space Flight Center (GSFC)	Paul Houser
Jet Propulsion Laboratory (JPL)	Randy Friedl
Marshall Space Flight Center (MSFC)	William LaPenta
Stennis Space Center (SSC)	Nathan Sovik

Federal Partners

US EPA Office of Water.....	Lauren MacWilliams
.....	Ed Partington
US EPA Office of Research and Development	Barbara Levinson
Bureau of Reclamation.....	Chuck Hennig
US Geological Survey Water Resources	Robert Hirsch
.....	William Kirby
NOAA Office of Hydrologic Development	Pedro Restrepo
NOAA Office of Global Programs	
GEWEX Americas Prediction Program.....	Jin Huang

NOAA National Operational Hydrologic
Remote Sensing Center Donald Cline
Agriculture Department (USDA)
Agricultural Research Service Dale Bucks
..... Tom Jackson
Natural Resources Conservatory Program Jon Werner
..... *Phil Pasteris*
..... *Garry Schaefer*

International, National and Regional Organizations

GEWEX: Global Energy and Water Cycle Experiment (Rick Lawford)
HELP: Hydrology for Environment, Life, and Policy (Jonathan Triggs)
IGOS: Integrated Global Observing Strategy (Rick Lawford)
GWSP: Global Water Systems Project (Charles Vörösmarty)
IFPRI: International Food Policy Research Institute

Distributed Active Archive Centers (DAAC) and Earth Science Modeling Centers

GSFC Earth Science DAAC (GES DAAC)
Land Processes DAAC (LP DAAC)
Langley Atmospheric Sciences DAAC (LaRC DAAC)
SPoRT Center: Short-term Prediction Research and Transition Center
GISS: Goddard Institute for Space Studies
GFDL: Geophysical Fluid Dynamics Laboratories
NCAR: National Center for Atmospheric Research
GMAO : Goddard Modeling and Assimilation Office

IV. Decision Support Tools and Water Management Issues

Priority Decision Support Tools: FY 05-09

Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)

BASINS is a GIS-based environmental analysis system sponsored by EPA. It incorporates several watershed models, allowing users to easily assess water quality using point and nonpoint source, watershed, and meteorological data. EPA operates BASINS to track and assess water quality, by computing the maximum amount of pollution that a water body is allowed to hold, better known as Total Maximum Daily Loads (TMDLs). These TMDLs are a standard measure in water pollution control and assessment. The primary BASINS submodel for evaluation is the Hydrologic Simulation Program-FORTRAN (HSPF). HSPF simulates nonpoint source runoff and pollution loadings for a watershed and performs water quality routing at hourly timesteps. BASINS-HSPF requires multiple data inputs, and its performance could be enhanced by several NASA science data products, such as precipitation, evapotranspiration, soil moisture, and runoff. Primary NASA products for evaluation include land cover and surface property products from TERRA and AQUA MODIS and water availability parameters from the NASA Land Information System (LIS). LIS includes inputs from a variety of NASA satellite products, primarily from MODIS, but also TRMM and AMSR.

Agricultural Water Resources Decision Support (AWARDS)

The Bureau of Reclamation operates AWARDS to assess the amount of water available for agriculture. These assessments are used to portion out limited water resources for various agricultural interests while retaining a portion for other uses (ecosystems, recreation, commerce, etc.). Potential NASA data products that could be used as inputs by AWARDS, include snow (liquid water equivalent), evapotranspiration, and soil moisture derived primarily from NASA MODIS and LIS data.

Water Supply and Demand Operation Models (Riverware and URGWOM)

The Bureau of Reclamation operates Riverware and Upper Rio Grande Operations Model (URGWOM) to advise river managers about the quantity of water expected at various points along a river. Within these models we are testing the use of NASA data in the USGS Precipitation-Runoff Modeling System (PRMS) and the Modular Modeling System (MMS). This information is used to help better manage the amount of water storage created by dams as well as viable economic activities that can be supported by a river. Estimating water supply in the river basin is critical and thus many NASA data products may be useful. Primary data for evaluation include MODIS land products (land cover, snow cover, surface temperature), LIS water availability products, and AMSR-E snow water equivalent and soil moisture products.

USDA Drought Monitoring and Water Supply Forecasting

The USDA operates several DSSs for water management in the US. One DSS used by the Natural Resources Conservation Service (NRCS) is a *water supply forecasting (WSF) tool*. WSF currently uses ground-based observations to monitor snow cover and snow water equivalent. NASA data from MODIS, AMSR, and LIS will be evaluated and tested. Potentially useful NASA data products are MODIS/AVHRR snow cover and AMSR snow water equivalent. Another DSS used by USDA is *SCAN/NIDIS (National Integrated Drought Information System)*. This system uses SCAN (Soil Climate Analysis Network) point-specific measurements of soil moisture to monitor drought conditions. NASA satellite data such as MODIS (land cover) and AMSR (soil moisture) and LIS modeling data could potentially improve spatial representation of soil moisture.

Impact-Water

The University of Colorado and IFPRI operate this policy-oriented DSS for use internationally to predict water availability and use to assess agricultural productivity. “The IMPACT model provides a consistent framework for examining the effects of various food policies, the impact of different rates of agricultural research investment on crop productivity growth, and income and population growth on long-term food demand and supply balances and food security².” (Rosegrant, Cai, and Cline, 2002) NASA remote sensing products, such as AMSR-E snow liquid water equivalent and MODIS surface and temperature and energy products may be useful for real-time and retrospective analysis using this tool. Also, NASA-supported weather and climate predictions can be tested for providing enhanced performance.

² From “World Water and Food to 2025, Dealing with Scarcity,” Mark W. Rosegrant, Ximing Cai, and Sarah A. Cline, <http://www.ifpri.org/pubs/books/water2025book.htm>

Potential Water Management Issues: FY 06-09

The program consults frequently with partners to identify important topics that need to be addressed by the Water Management Team. These topics may deal with unaddressed issues facing the water supply community, examination of new relevant decision support tools, evaluation of future remote sensing systems or other mechanisms and/or activities that would be beneficial to policy and decision makers. A list of potential topics that may require consideration and more prominence in the Water Management Program Element portfolio include:

- Nonpoint source pollution
- Vegetation type and evapotranspiration
- Long-term water storage
- Water quality assessments and comprehensive descriptions of data sources
- Potential for new data sources
- LDAS and LIS to provide Hydrometeorological data for sparse regions driving DSS tools
- Implement short and long term climate predictions, and weather forecasting, into water management DSS tools.

Cross Program Element Activities

The Water Management Team coordinates and evaluates activities jointly with other Program elements on crosscutting topics and DSTs. Possible cross-cutting program elements include:

Agricultural Efficiency: Water Supply

In the United States, regional use of water is largely for agriculture (i.e. irrigation), estimates range from fifty to ninety percent. Water consumption as a portion of water use for irrigation is even greater outside the United States. Working with USDA, both the Agricultural Efficiency and Water Management Programs provide as much information as possible to aid in estimating the amount of water both available for agriculture and consumed by agriculture. Initially this activity is evaluating SWAT, however other USDA decision support tools are identified and evaluated for potential benefit from NASA products.

Disaster Management: Floods and Droughts

Of natural disasters, floods and droughts are among the most costly to the United States. NASA data is useful for assessing the areal extent of flood inundation. NASA can enable seasonal predictions to assess the potential for drought in various areas. Both the Disaster Management and Water Management Program Elements investigate the extension of NASA data to aid FEMA and other agencies to alleviate the stresses caused by these phenomena.

Energy Management: Snowpack Assessment

United States generates a significant amount of electricity from hydropower. In the Western states a majority of the water used for this purpose was previously stored in the snow pack. Better assessments of the size of the snow pack may be useful for increasing the efficiency of power generation as well as early estimates, seasonally, for potential hydropower generation. The Energy Management and the Water Management Programs work, with other agencies, to transition information from NASA to decision support tools employed by the Bureau of Reclamation, the Department of Energy, and others, for these purposes.

Water Management: Integrated System Solution Diagram

Appendix A contains the Water Management Integrated System Solution Diagram. This diagram illustrates the extension of Earth science measurements, model products, and data fusion techniques to support the Water Management Program's partners, their decision support tools, and the value and benefits of Earth-Sun System science to society.

V. Application Activities

A. Projects

The Water Management Program authorizes peer-reviewed projects to support the goals and objectives. The respective Project Managers are responsible for developing project plans and managing the activities. Funding across the projects in FY05 is \$150K.

Project BASINS				
The goal is to verify and validate Earth-Sun System science products, especially land surface model products, for beneficial, routine use in EPA's BASINS decision support tool. A regional test project will be initiated to connect LDAS outputs with BASINS, for use to model the Patuxent Watershed. MODIS data will either be infused into LDAS first, or directly into BASINS.				
<i>Project Managers</i>	<i>Centers</i>	<i>Timeframe</i>	<i>Partners</i>	
David Toll-GSFC	GSFC	FY05-FY09	EPA	
<i>Earth-Sun System Science Products</i>	Terra – MODIS, Aqua – MODIS, Model – LDAS/LIS			<i>Other Apps.</i>
<i>Deliverables</i>	Evaluation report, contact network, agreement/joint development plan, international activities report, benchmark report, results conference(s)			Coastal Management

Project AWARDS and RiverWare				
The goal of this project is to establish relationships and to evaluate, validate and benchmark Earth-Sun System science products, especially spacecraft and land surface model, for beneficial, routine use in assessment of water availability for agriculture, based on large scale region assessment (Awards) and for river stage condition (Riverware).				
<i>Project Managers</i>	<i>Centers</i>	<i>Timeframe</i>	<i>Partners</i>	
Kristi Arsenault - GSFC	GSFC	FY05-FY09	BoR	
<i>Earth-Sun System Science Products</i>	Terra – MODIS, Aqua – MODIS, AMSR-E, Model – LDAS/ LIS			<i>Other Apps.</i>
<i>Deliverables</i>	Evaluation report, contact network, agreement/joint development plan, international activities report, benchmark report, results conference(s)			Agricultural Efficiency, Energy Forecasting

Project USDA NRCS WSF and SCAN/NIDIS				
The goal of this project is to establish relationships and to evaluate, validate and benchmark Earth-Sun System science products, especially spacecraft products and land models, for improving performance of the NRCS water supply forecasts and drought monitoring.				
<i>Project Managers</i>	<i>Centers</i>	<i>Timeframe</i>	<i>Partners</i>	
Jonathan Triggs	GSFC,	FY05-FY09	USDA	
<i>Earth-Sun System Science Products</i>	Terra – MODIS, Aqua – MODIS, Model: LDAS/LIS			<i>Other Apps.</i>
<i>Deliverables</i>	Evaluation report, contact network, agreement/joint development plan, international activities report, benchmark report, results conference(s)			Agricultural Efficiency

Project Impact-Water				
The project is evaluating the use of NASA data products in Impact-Water. After an evaluation report is completed, the project will use data products with the best potential and commence activities for verification, validation, and providing a benchmark report on the improvement to Impact-Water performance. The activity may repeat the process using different potentially beneficial products, after initial benchmark reports are completed.				
<i>Project Managers</i>	<i>Centers</i>	<i>Timeframe</i>	<i>Partners</i>	
David Toll - GSFC	GSFC	FY05-FY09	U. Colorado, IFPRI	
<i>Earth-Sun System Science Products</i>	Terra – MODIS, Aqua – MODIS, AMSR-E, TRMM			<i>Other Apps.</i>
<i>Deliverables</i>	Evaluation report, contact network, agreement/joint development plan, international activities report, benchmark report, results conference(s)			Agricultural Efficiency

Project LIS				
This project continues a competitively selected project. The project (LIS) scheduled to end in FY'04, was initiated to do land surface modeling (similar to LDAS) at a higher resolution, 1 km. The project was initiated as a test of computational engineering. The project has achieved its objectives and a continuation led by the Water Management Program Element would provide land surface information at 1 km. Generating data at this resolution is more conducive to meeting the needs of our partners in water management projects. In FY05, the program will examine the possibility for continuation and expansion of this project by Crosscutting Solutions.				
<i>Project Manager</i>	<i>Centers</i>	<i>Timeframe</i>	<i>Partners</i>	
Paul Houser - GSFC	GSFC	FY05-FY09	NOAA, EPA, BoR, etc.	
<i>Earth Science Products</i>	Terra-MODIS, Aqua-MODIS, AMSR-E; TRMM Models: LDAS			<i>Other Apps.</i>
<i>Deliverables</i>	Evaluation report, contact network, agreement/joint development plan, benchmark report, results conference			Homeland Security, Agricultural Efficiency, Public Health, Ecological Forecasting, Invasive Species, Air Quality

B. Solicitations

The Water Management Program Element leverages appropriate activities, expertise, and assets selected through solicitations and research announcements to serve the program element's objectives. For proposals selected through solicitations funded by the Applied Sciences Program, the Water Management Program may provide supplemental funding. In addition, the program element may provide funds to projects selected or identified through other Science

Mission Directorate solicitations. The program and project managers facilitate appropriate partnerships between solicitation recipients and NASA partners.

The Water Management Program plans to solicit projects in FY05-09 through multiple solicitations. These solicited projects will enhance the existing projects listed above as well as enlarge the Water Management Program.

Pending Solicitations

NEWS: The NASA Energy- and Water-cycle Sponsored research (NEWS) solicitation. The entire solicitation solicits research for both science and applications projects related to various components of the water and energy cycles. There is a portion of this solicitation that focuses on issues of importance to the water management community. The solicitation also seeks to connect applications-oriented projects directly with a larger-scale NASA project that is driven by the need to produce Energy and Water-cycle products (in contrast to most NASA research projects that are more discovery driven).

DECISIONS: This solicitation focuses on issues of importance to all twelve of the national program elements. Projects chosen from this NRA, for water management, will have overlap with at least one other national program element.

Future Solicitations

ROSES'06: This solicitation seeks projects that connect products of the research community with Water Management Program Elements. In particular this announcement seeks to extend product from the NEWS NRA grants, REASoN cooperative agreement notices (initiated in FY03), and the Interdisciplinary Science NRA grants (initiated in FY04).

ROSES'08: This solicitation is similar to ROSES'06, though in FY08 there will be additional observational spacecraft data sets available that will be useful to the water management community. In addition, this announcement will look to extend any result from the emerging field of observations taken from Unmanned Aerial Vehicles (UAVs).

C. Congressionally Directed Activities

There are no congressionally directed activities related to the Water Management Program Element in FY05.

D. Project Management

The Water Management Program Element authorizes activities that contribute to the overall success of the program element through studies, working groups, program reviews, and other endeavors.

Program Planning

The purpose of this activity is to identify important water management issues and evaluate associated management responsibilities and decision support tools in order to determine opportunities the program element may support in the future. The purpose of this activity is to examine the strategies and plans of existing and potential partner organizations to identify their topics, directions, mandates, and responsibilities. The information and analysis will identify possible applications of Earth-Sun System science research results to support the partners as well as help the application develop and structure partnerships. This should include two exploratory efforts; the first is the transfer of knowledge and experience of data assimilation to the Office of Hydrology. The second is the evaluation of seasonal climate forecast products for use in DSS.

Lead: David Toll

Centers: GSFC (Lead), SSC, MSFC, JPL

Timeframe: FY05-FY09

Budget: 70K (including 20K for Water Working Group)

Deliverables: Meeting reports, Evaluation reports on issues and decision support tools.

Exploration of pre-evaluation of use of Earth-Sun System Science products for other national and international DSS.

Program Alignment

The Water Management Program Element activities need to be performed in synergy with the evolving needs and priorities of our partner agencies. NASA is involved in various interagency working groups to facilitate these interactions. The first is the Subcommittee for Water Availability and Quality to the Committee for the Environment and Natural Resources (part of the Office of Science Technology and Policy (OSTP)). This Subcommittee provides guidance to the administration on critical issues in water management. Also, the water management program is participating in the Water Resources Research Coordinating Committee. This committee provides an opportunity for the many agencies involved with water management to update other agencies on their activities. This committee is an invaluable resource to maintain a sufficient knowledge base of other agencies' activities, priorities, and plans.

Lead: David Toll

Centers: GSFC (Lead), SSC, MSFC, JPL

Budget: 50K

Timeframe: FY05-FY09

Deliverables: Society planning and priority setting meetings and meeting reports; reports on issues, DST for national water priorities; and exploration of interagency activity towards use of Earth-Sun System Science products for other national and international DSS.

E. Additional Activities and Linkages

In general, the NASA Water Management Program Element is following program direction to emphasize the link to the following activities:

The Crosscutting Solutions Program—The program consists of functional elements that contribute to all of the National Applications activities. The intention is to have the performance of these functions leverage accomplishment, and therefore the apparent resource investment, to the greatest extent possible into the National Applications partnerships. These functions are: Geoscience Standards and Interoperability, Human Capital Development, Integrated Benchmark Systems, and Solutions Networks. Examples of leveraged activities are:

- *The Earth-Sun System Gateway* is a “portal of portals” providing an access point through an Internet interface to all web-enabled NASA research results.
- *A Rapid Prototyping Center* is a proposed center at Stennis to support NASA and partners in testing and verification of Earth science results in decision support tools.
- *Transition from Research to Operations Network (R2O)* is a network that focuses on systematically transitioning the results of research to operational uses.
- *DEVELOP* is a student-based program for rapidly prototyping solutions for state and local applications and helping students develop capabilities related to applied Earth-Sun science.

NASA and Science Mission Directorate Priorities

- *Federal Enterprise Architecture (FEA)* is a business and performance-based framework to support cross-agency collaboration, transformation, and government-wide improvement.
- *The Global Information Grid (GIG)* is the first stage of a U.S. military global, high-bandwidth, Internet protocol-based communications network (a.k.a., ‘the Internet in space’).
- *The Joint Center for Satellite Data Assimilation (JCSDA)* is a multi-agency collaboration to accelerate and improve the quantitative use of research and operational observational spacecraft data in weather and climate prediction models. NOAA (NESDIS, NWS, OAR), NASA, Navy, Air Force, and NSF (through UCAR) collaborate in JCSDA.
- *Metis* is a visual modeling software tool for planning, developing, and analyzing agencies' enterprise architectures. The Applied Sciences Program is using Metis to identify possible linkages between observations, models, and decision support tools to support the IWGEO and NASA/NOAA R2O activities.
- *Observing System Simulation Experiments (OSSEs)* use simulated observations to assess the impacts of future observational spacecraft instruments on weather and climate prediction and provide opportunities to test new designs and methodologies for data gathering and assimilation.
- *Project Columbia* is a NASA-wide project to develop a new, fast supercomputer (using an integrated cluster of interconnected processor systems) to support the Agency's

mission and science goals, including enhanced predictions of weather, climate, and natural hazards.

The Water Management Program draws on activities supported by the Earth-Sun system science community and the Earth Science Education programs that may have potential or specific applications to the program element's goals and objectives. The Water Management Program Element monitors the activities for potential support.

Appendix D lists the solicitations, new investigators, and fellowships related to Water Management activities.

VI. Budget: Fiscal Year 2005

The following table lists the Water Management Program budget (procurement) for FY2005:

Water Management	
Project	FY05 Procurement Allocation (\$K)
NEWS NRA	\$600
Project Activity	\$150
Program Planning and Alignment	\$120
Total	\$870

Appendix C lists program-wide budget allocations for FY2005.

VII. Schedule and Milestones

Meetings

American Meteorological Society Annual Meeting: "*Building the Earth Information System*". (Sub-themes: *Living with a limited Water Supply* and *Living in the Coastal Zone*.) Jan. 9-13, 2005 – San Diego, California.

Second NASA-USDA meeting: April 11-13, New Orleans, Louisiana.

5th International Scientific conference on the Global Energy and Water cycle, June 20-24, 2005, Orange County, California (Abstracts due 16 January)
Drought Workshop, UMUC (College Park, MD), May 17-19

Fourth World Water Forum. 2007 – Mexico.

VIII. Performance Measures

The Water Management team uses performance measures to track progress, identify issues, evaluate projects, make adjustments, and establish results of the program element. The

program's goal and objectives (Section II) state what the program intends to achieve. These measures help the team monitor progress within and across specific activities to ensure the program meets its goal and objectives.³ The management team analyzes these measures retrospectively in order to make adjustments proscriptively to the program approach and objectives.

The measures are in two categories (tables below): Program Management measures are internally focused to assess the activities within the program. Performance measures are externally focused to assess if the program activities are serving their intended purpose. In general, the Water Program uses these measures to evaluate the performance of activities conducted and sponsored by the program, especially the projects. In addition, the Applied Sciences Program uses this information in preparing IBPD directions and PART responses.

Program Management Measures (Internal):

Inputs	<p>Potential issues and DST identified for Water Management – <i>number, type, range</i></p> <p>Eligible partners to collaborate with – <i>number, type, range</i></p> <p>Potential results/products identified to serve Water Management – <i>number, type, range</i></p>
Outputs	<p>Assessments or evaluations of DSTs – <i>number, range</i></p> <p>Assessments of Earth-Sun System science results/products to serve DST – <i>number, range</i></p> <p>Agreements with partners – <i>presence</i></p> <p>Reports (evaluation, validation, benchmark) – <i>number, type</i></p>
Quality and Efficiency	<p>Earth-Sun System science results/products – <i>number used per DST, ratio of utilized to potential</i></p> <p>Agreements – <i>ratio of agreements to committed partners</i></p> <p>Reports – <i>partner satisfaction, timeliness, time to develop</i></p> <p>Reports – <i>ratio of validations to potential products, ratio of benchmarks to validations</i></p>

³ *These measures are like gauges in an automobile - they serve as indicators to help the management team track conditions and identify issues in order to keep the program aligned with the plan & meet its objectives.*

Performance & Results Measures (External):

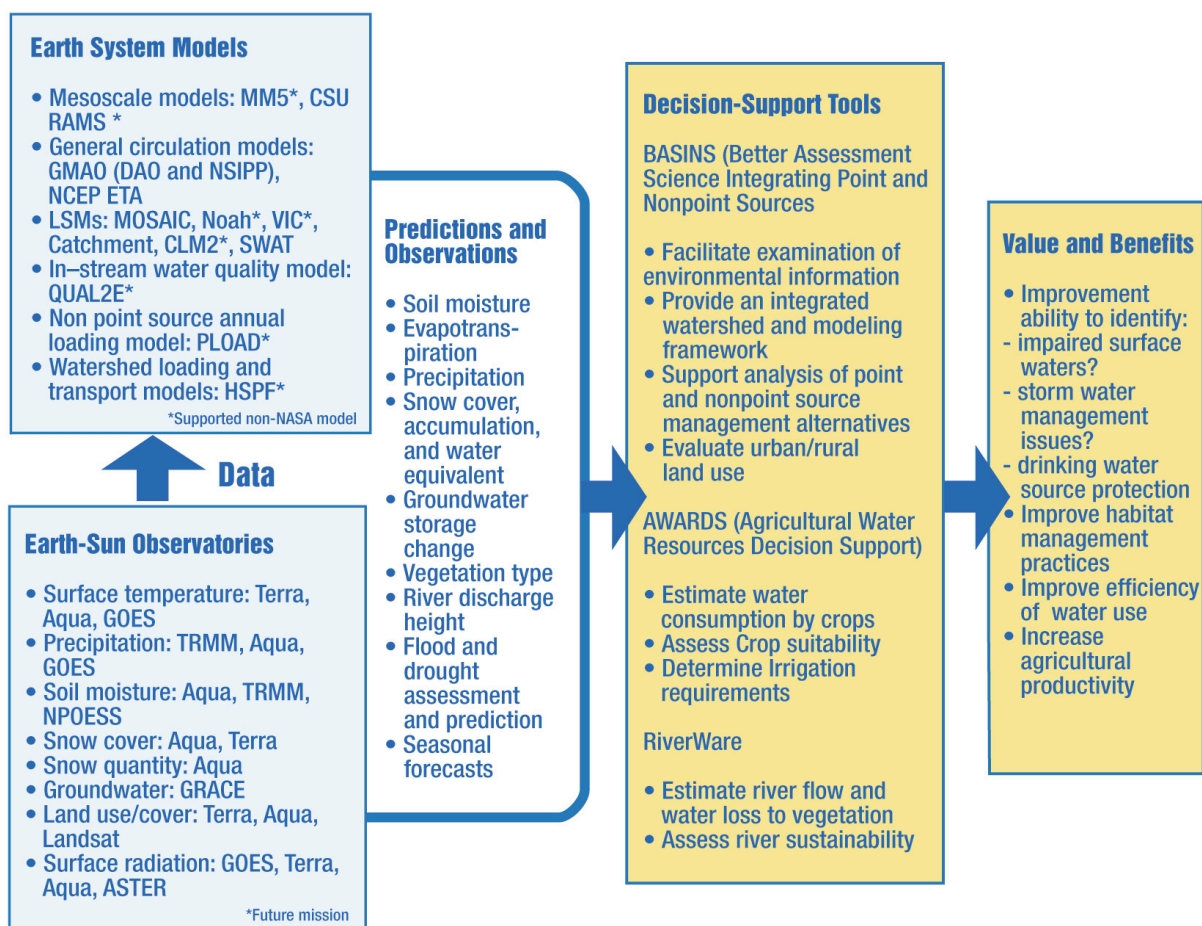
Outcomes	<p>Earth-Sun System science products adopted in DST – <i>number, type, range; use in DST over time</i></p> <p>Earth-Sun System science products in use – <i>ratio of products used by partners to reports produced</i></p> <p>Partner & DST performance – <i>change in partner DST performance, number and type of public recognition of use and value of Earth science data in DST</i></p>
Impacts	<p>Partner value – <i>change in partner metrics (improvements in value of partner decisions)</i></p>

In addition to the stated measures, the Water Management Program periodically requests an assessment of its plans, goals, priorities, and activities through external review. The Water Management team uses these measures along with comparisons to programmatic benchmarks to support assessments of the Applied Sciences Program (e.g. internal NASA reviews and OMB PART). In specific, Water Management uses comparisons to similar activities in the following programs (i.e., program benchmarks) to evaluate its progress and achievements:

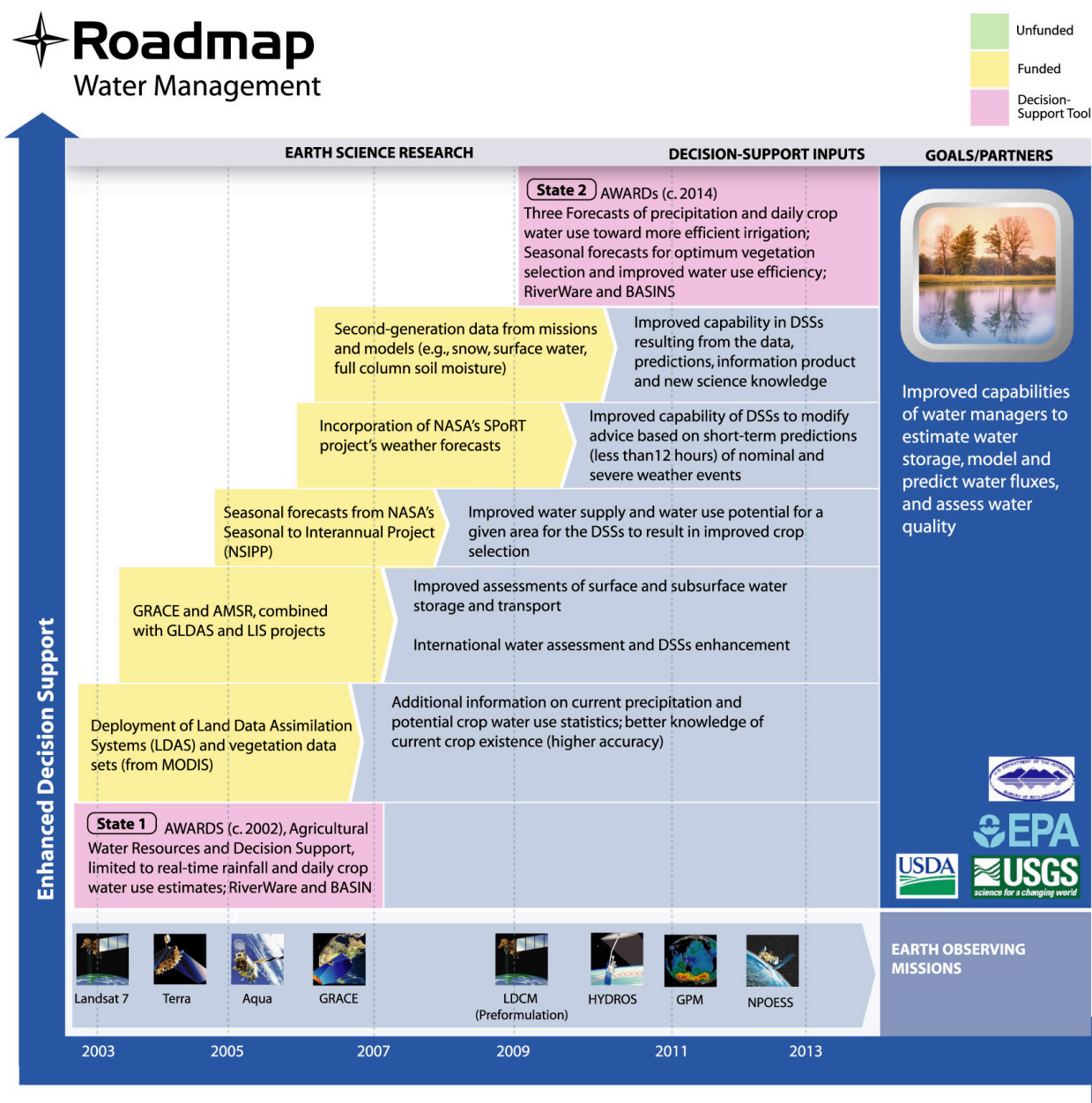
- Environmental and Societal Impacts Group at NCAR
- NCAR Research to Applications Group
- Global Monitoring for Environment and Security (GMES) in Europe

IX. Appendices

Appendix A. Integrated System Solution Diagram



Appendix B. Roadmap



Appendix C. Applied Sciences Program Budget FY2005

The overall program budget allocations are given below to provide the context in which this National Application is conducted. The allocations are based on Agency and program priorities and are subject to change according to the availability of funds and programmatic strategies. All values are in thousands of dollars.

*NOTE: Allocations include full utilization of the Applied Sciences FY04 carryover of approximately \$2.7 million.

Table 1: Applied Sciences Procurement Allocation – FY05

Program Element	FY05 Procurement Allocation
National Applications	
Agricultural Efficiency	\$ 467
Air Quality Management	\$ 995
Aviation	\$ 750
Carbon Management	\$ 653
Coastal Management	\$ 550
Disaster Management	\$ 545
SENH	\$ 1,429
Ecological Forecasting	\$ 610
Energy Management	\$ 775
Homeland Security	\$ 205
Invasive Species	\$ 205
Public Health	\$ 725
Water Management	\$ 870
Program Director Discretionary Fund	\$ 588
Center Director Discretionary Fund Tax	\$ 2,485
National Applications Total	\$ 11,852
Crosscutting Solutions	
Integrated Benchmarked Systems	\$ 3,529
Solutions Networks	\$ 1,200
Competitive Solicitations	\$ 7,600
Human Capital Development	\$ 700
Geoscience Standards & Interoperability	\$ 2,000
Crosscutting Solutions Total	\$ 15,029
Applied Sciences Program Procurement Total	\$ 26,881

Table 2: Applied Sciences Program NASA Institutional Allocations – FY05

NASA Center	FY05 Institutional Cost / National Applications	FY05 Institutional Cost / Crosscutting Solutions	Institutional Total
HQ	\$3,773	\$7,351	\$11,124
ARC	\$1,108		\$1,108
GSFC	\$1,009	\$1,094	\$2,103
JPL			
LaRC	\$1,517	\$444	\$1,961
MSFC	\$1,251	\$183	\$1,434
SSC	\$3,194	\$8,689	\$11,883
Total	\$11,852	\$17,761	\$29,613

Appendix D. Related NASA and Partner Solicitations and Grants

Solicitations

Reason Can: Application-oriented Proposals

<u>Institution</u>	<u>PI</u>	<u>Title/Subject</u>	<u>Award Years</u>
University of California – Santa Barbara	Jeff Dozier (Applications PI – Roger Bales)		2003–2008
Earth System Science Research Using Data and Products from Terra, Aqua, and Acir Satellite			
<u>Institution</u>	<u>PI</u>	<u>Title/Subject</u>	<u>Award Years</u>
GSFC	Robert Adler	Use of AQUA information in Global Multi-Satellite Precipitation Analysis	2003–2005
University of Oklahoma	Keith Brewster	Impact of Assimilation of AIRS Soundings and AMSR-E Rainfall on Short Term Forecasts of Mesoscale Weather	2003–2005
University of California Davis	Shu-Hua Chen	Studies of the Impact of Assimilating MODIS Data from Terra and Aqua on Weather Simulations/Forecasts	2003–2005
Marshall Space Flight Center	William Crosson	Improving Weather Forecasts by Assimilating EOS Satellite Data	2003–2005
USDA	Wade Crow	Improving Flood Forecasts Through the Integration of AQUA Satellite Products with a Macroscale Hydrologic Model	2003–2005
Massachusetts Institute of Technology	Dara Entekhabi	Global Estimates of Evaporation from Variational Assimilation of Multi-Platform Land Surface Temperature into a Dynamic Model of the Surface Energy Balance	2003–2005
University of New Hampshire	Balazs Fekete	Monitoring Inland Water Bodies Using TERRA and AQUA Satellite Sensors	2003–2005
Purdue University	Jennifer Haase	Studies of the Impact of Assimilating MODIS Data from Terra and Aqua on Weather Simulations/Forecasts	2003–2005
Jet Propulsion Laboratory	Eni Njoku	Aqua/AMSR-E Soil Moisture Algorithm and Product Improvements	2003–2005
Creighton University	Joan Ramage	AMSR-E Derived Snow Melt Timing and Its Hydro-Geomorphologic Influences in Heterogeneous Terrain, Upper Yukon River Basin	2003–2005
University of Montana	Steven Running	EOS Algorithm Refinement Proposal – Global Validation and Refinement of the MOD 17 Terrestrial Net Primary Production and MOD 16 Evaporative Index	2003–2005
University of California Davis	Susan Ustin	Global Estimation of Canopy Water Content	2003–2005
Princeton University	Eric Wood	A Terrestrial Evaporation Data Product Using MODIS Data	2003–2005

IDS NRA: Application-oriented proposals

<u>Institution</u>	<u>PI</u>	<u>Title/Subject</u>	<u>Award Years</u>
Georgia Institute of Technology	Robert Dickinson	Using MODIS Data to Characterize Climate Model Land Surface Processes and the Impacts of Land Use/Cover Change on Surface Hydrological Processes	2003–2005
University of Wisconsin, Madison	Jonathan Foley	Agricultural Land Use and the Transformation of Planet Earth: Investigating the Effects of land Use Practices on the Ecological Biogeochemical and Hydrological Systems of the Planet	2003–2005
East-West Center (U. of Hawaii)	Jefferson Fox	The Role of Land-Cover Change in Montane Mainland Southeast Asia in Altering Regional Hydrological Processes Under a Changing Climate	2003–2005
USDA	William Kustas	Accounting for Effects of Subpixel Surface variability on regional Flux Estimation Using Large Eddy Simulation with Terra and Aqua Sensors	2003–2005
Colorado State University	Glen Liston	Parameterizing Subgrid Snow-Vegetation-Atmosphere Interactions in Earth-System Models	2003–2005

USGS	Thomas Loveland	The Influence of Historical and Projected Land Use and Land Cover Changes on Land Surface Hydrology and Regional Weather and Climate Variability	2003-2005
Colorado State University	Roger Pielke	Integrated Regional Climate Study with a Focus on the Land-Use Land-Cover Change and associated Changes in Hydrological Cycles in the South Eastern United States	2003-2005
University of Colorado, Boulder	Eric Small	Modeling the Influence of Plant Cover on Water and Energy Cycling at the Land-Atmosphere Interface: Constraints from Satellite and Ground Data	2003-2005
University of California – Irvine	Soroosh Sorooshian	Towards an EOS-Enhanced Hydrological Prediction System	2003-2005
University of Maryland – ES	Philip Townsend	Spatial Patterns of Forest Disturbance and Consequences for Regional Water Quality	2003-2005

Fellowships

Funded under Earth Science Education – Fellowship Program

<u>Institution</u>	<u>PI</u>	<u>Title/Subject</u>	<u>Award Years</u>
Duke University	Darren Drewry	Constrained Regional Land-Atmosphere Exchange Predictions in a Semi-Arid Region: Advancing Ecohydrologic Data Assimilation	2003-05
MIT	Susan Dunne	Using Ensemble Smoothing Techniques to Obtain Dynamically Consistent Soil Moisture and Surface Flux Estimates; Assessing the Added Value of Future Observations in Mission Design Studies	2003-05
U. of Arizona	Derrick Lampkin	Mapping Alpine Snowmelt Over the Colorado River Basin Using Multiple Satellite Platforms: MODIS and AVHRR Data for Monitoring Variability in Regional Climate and Water Resources	2003-05
Purdue University	Pablo Mercuri	Terrain Analysis and Surface Hydrologic Modeling Strategies Using High-Resolution Global Digital Topography	2003-05
Howard University	Andrea Sealy	The Impact of Soil Moisture Initialization on Seasonal Precipitation Forecasts in West Africa	2003-05
Texas A&M University	Sanjay Kumar Sharma	Analysis and Assimilation of Soil Moisture from Ground-, Air-, and Space-Borne Sensors	2003-05
Florida University	Kai-Jen Tien	Linking Changes in Dynamic Vegetation to Passive Microwave Remote Sensing	2003-05
University of Maryland College Park	Megan Weiner	Radar Monitoring of Hydrologic Variability in Maryland's Forested Coastal Plain Wetlands	2003-05
University of Iowa	Mekonnen Woldemariam	Characterization of the Spatial Variability of Rainfall from Remote Sensing	2003-05

New Investigators

Funded under Earth Science Education – New Investigator Program (NIP)

<u>Institution</u>	<u>PI</u>	<u>Title/Subject</u>	<u>NIP Award Years</u>
University of Utah	Richard Forster	A Multi-Sensor (Multi-Scale) Approach to Snowmelt Detection Using Active and Passive Microwave Remote Sensing	2002–2005
GSFC	Marshall Shepherd	Investigation of Urban-Induced Precipitation Using Satellite-Based Remote Sensing and Numerical Modeling: Linking Land Use and Change to Variations in the Global Water Cycle	2002–2005

Appendix E. Acronyms and Websites

ACRONYMS:

ACRIM	Active Cavity Radiometer Irradiance Monitor Satellite
AHPS	Auxiliary Hydraulic Power supply
AIRS	Airborne Infrared Sounder
AIRS	Alliance Icing Research Study
AIWG	Applications Implementation Working Group
AMSR-E	Advanced Microwave Scanning Radiometer-EOS (Japanese)
Aqua	EOS Spacecraft
Aquarius	Mission to measure global Sea Surface Salinity
ARC	Ames Research Center
AVHRR	Advanced Very High Resolution Radiometer
AWARDS	Automated Weather Acquisition and Retrieval System
BASINS	Better Assessment Science Integrating Point and Non-point Sources
BoR	Bureau of Reclamation (Department of Interior)
CCSP	Climate Change Science Program
CLM	Center for Navel Amylases
CloudSAT	A NASA Earth System Science Pathfinder Mission
DAAC	Distributed Active Archive Center (Data Active Archive Center)
DOI	US Department of the Interior
DSS	Decision Support Systems
DST	Decision Support Tool
EO-1	Earth Observing-1
EOS	Earth Observing Systems
EPA	US Environmental Protection Agency
ESA	Earth Science Applications
ESG	Earth-Sun System Gateway
ESTO	Earth-Sun System Technology Office
FEA	Federal Enterprise Architecture
FEMA	Federal Emergency Management Agency
FY	Fiscal Year
GCM	Global Climate Model
GES	Geospatial Extension Service
GEWEX	Global Energy and Water Cycle Experiment
GFDL	Geophysics Fluid Dynamics Laboratory
GIG	Global Information Grid
GISS	Goddard Institute for Space Studies
GMAO	Global Modeling and Assimilation Office
GMES	Global Monitoring for Environment and Security
GPM	Global Precipitation Measurement
GRACE	Gravity Recovery and Climate Experiment
GSFC	Goddard Space Flight Center
GWSP	Global Water Systems Project
HELP	Hydrology for Environment, Life, and Policy
IBPD	Integrated Budget and Performance Document
IFPRI	International Food Policy Research Institute
IGOS	Integrated Global Observations Strategy
IMPACT	Interactive Modeling Project for Atmospheric Chemistry and Transport
IWGEO	Interagency Working Group on Earth Observations

JCSDA	Joint Center for Satellite Data Assimilation
JPIP	JPEG2000 Internet Protocol
JPL	Jet Propulsion Laboratory
LaRC	Langley Research Center
LDAS	Land Data Assimilation System
LIS	Lightning Imaging Sensor
LSM	Lightning Mapper Sensor
LP	Land Processes
MIT	Massachusetts Institute of Technology
MM5	Mesoscale Model
MODIS	Moderate Resolution Imaging Spectroradiometer
MOU	Memorandum of Understanding
MSFC	Marshall Space Flight Center
NASA HQ	NASA Headquarters
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NESDIS	National Environmental Satellite Data Information Service
NEWS	NASA Energy- and Water- cycle Study
NIP	New Investigator Program
NOAA	National Oceanic and Atmospheric Administration
NOAH	A Land Surface Model
NPOESS	National Polar-Orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project/Net Primary Productivity
NRA	NASA Research Announcement
NSF	National Science Foundation
NWS	National Weather Service
OAR	Office of Oceanic and Atmospheric Research
OMB	Office of Management and Budget
OSSE	Observing System Simulation Experiment
OSTP	Office of Science and Technology Policy
PART	Program Assessment Rating Tool
R2O	Research to Operations Network
RAMS	Regional Atmospheric Modeling System
REASoN	Research, Education, and Applications Solutions Network
SEA	State Enterprise Architecture
SPoRT	Short-term Prediction Research and Transition Center
SSC	Stennis Space Center
SWAT	Soil and Water Assessment Tool
TERRA	Not an Acronym
TMDL	Total Maximum Daily Loads
TRMM	Tropical Rainfall Measurement Mission
UAV	Unmanned Aerial Vehicles
UCAR	University Corporation for Atmospheric Research
UMUC	University of Maryland University College
USDA	US Department of Agriculture
USGS	United States Geological Survey
VIC	Variable Infiltration Capacity (Macroscale Model)

WEBSITES:

AIWG: <http://aiwg.gsfc.nasa.gov/>

Applied Sciences Program: <http://science.hq.nasa.gov/earth-sun/applications>

DEVELOP: <http://develop.larc.nasa.gov>

Earth-Sun System Gateway (ESG): <http://esg.gsfc.nasa.gov/>

Earth-Sun Science System Components: <http://www.asd.ssc.nasa.gov/m2m>

NASA FY2005 Budget: <http://www.ifmp.nasa.gov/codeb/budget2005>

Research and Analysis Program: <http://science.hq.nasa.gov/earth-sun/science/>

Science Mission Directorate: <http://science.hq.nasa.gov>

Science Strategies: <http://science.hq.nasa.gov/strategy/>